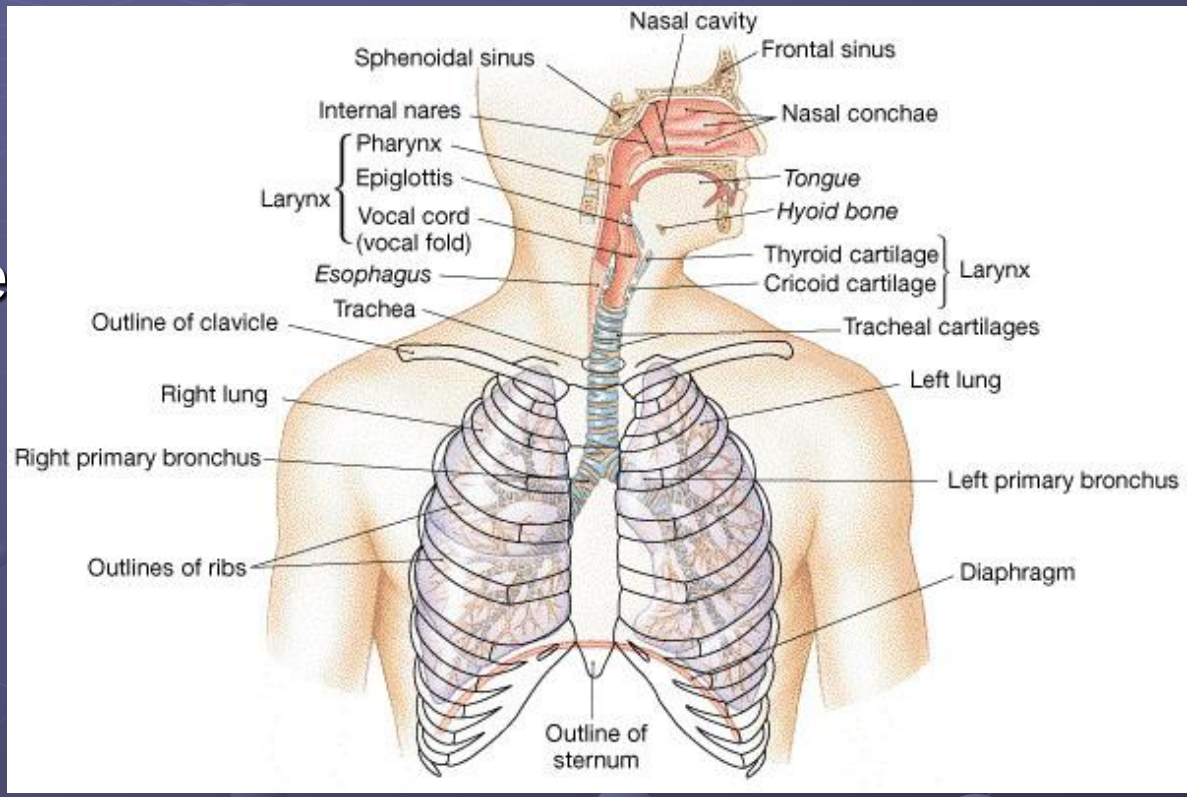
Ch. 22: The Respiratory System

Explain the microscopic and gross anatomy of the respiratory system.

Identify the pleural cavities, its membranes and the muscles of ventilation.



Developed by
John Gallagher, MS, DVM

LAS POSITAS COLLEGE

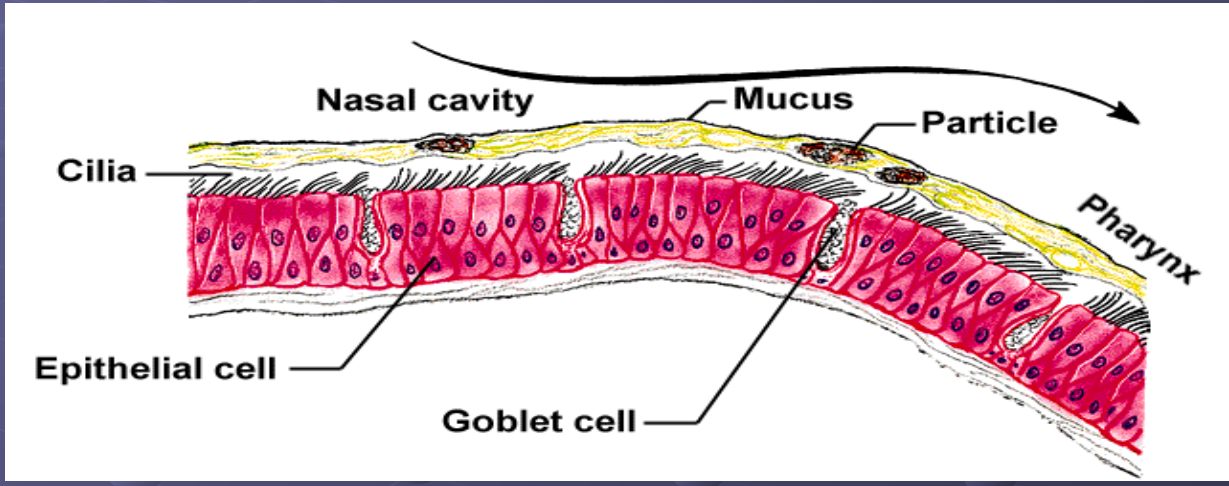
Respiratory system tasks

- 1° Functions:
  - Gas Transport
  - Gas Exchange
    - O_2 and CO_2 via diffusion
  - Acid-Base Balance
    - $CO_2 + H_2O \rightleftharpoons H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$
- 2 ° Functions:
  - Moistening and warming/cooling
  - Particulate/pathogen removal

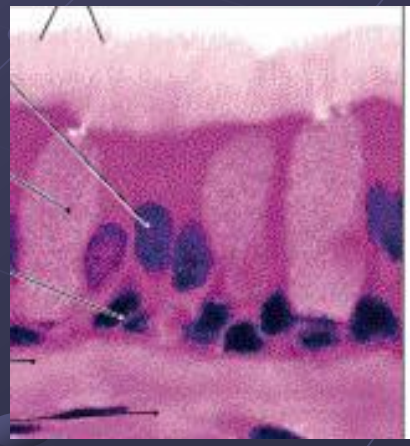
Understand this formula!

Respiratory Epithelium (review ch. 4)

- **Histology? Pseudo…**
- **Mucus produced by numerous goblet cells**



Defense by means of
- •filtering hairs
- •turbinates
- •ciliary escalator (mucociliary blanket)
- •sticky mucus



Respiratory System starts at the nares

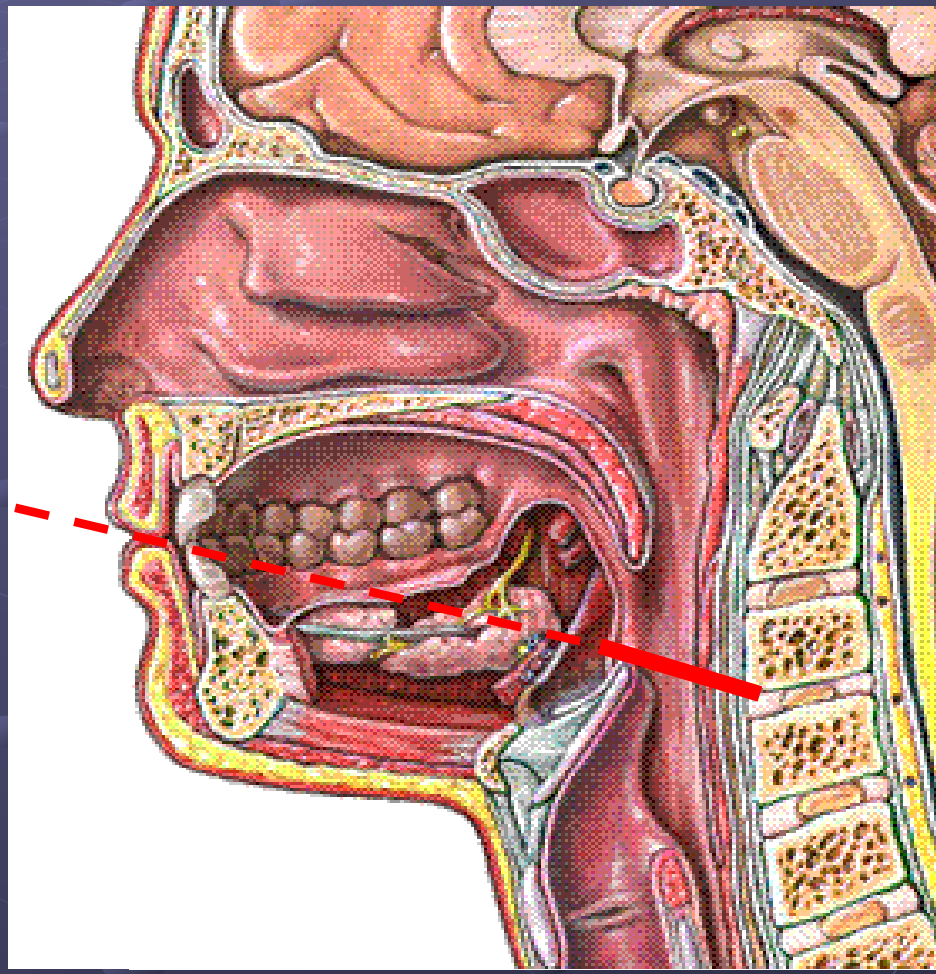
Major Functions

Upper respiratory system:

1. Air conditioning (warming)
2. Defense against pathogens
3. Gas Transport

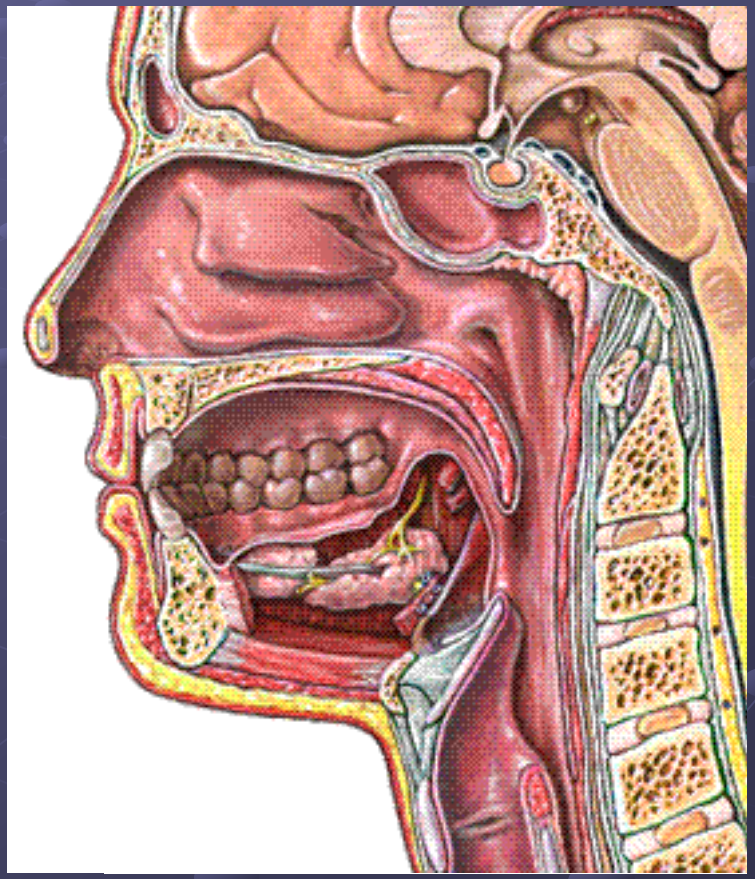
Lower respiratory system:

1. Speech & other respiratory sounds
2. Gas exchange (ventilation)
3. Maintenance of homeostasis, e.g. pH

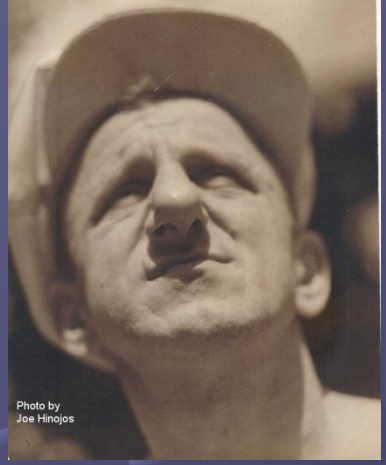


Upper Respiratory System

1. Nose
2. Nasal Cavity
3. Paranasal sinuses
4. Pharynx

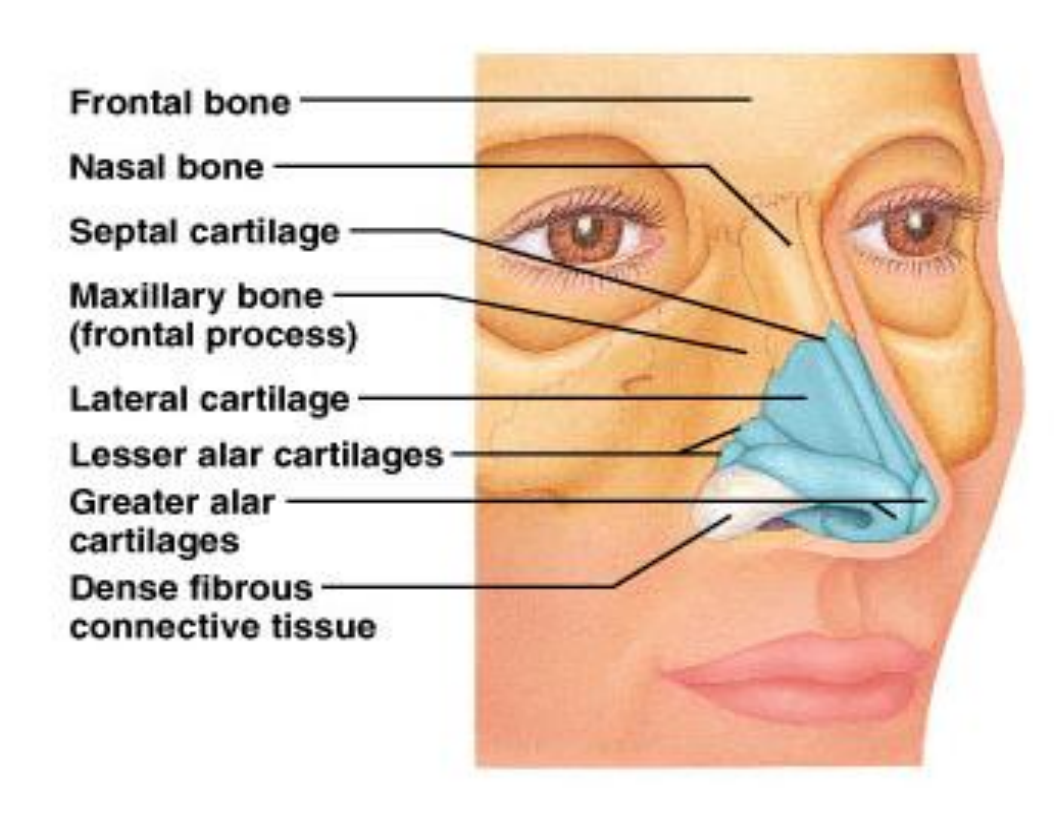


Upper Respiratory System



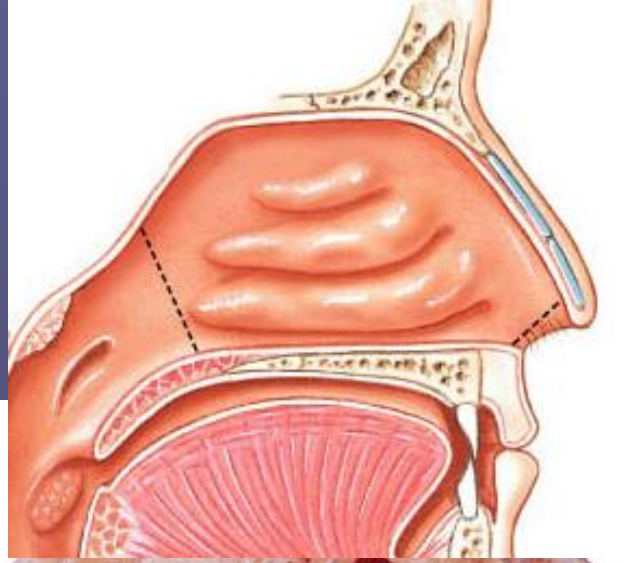
1) Nose

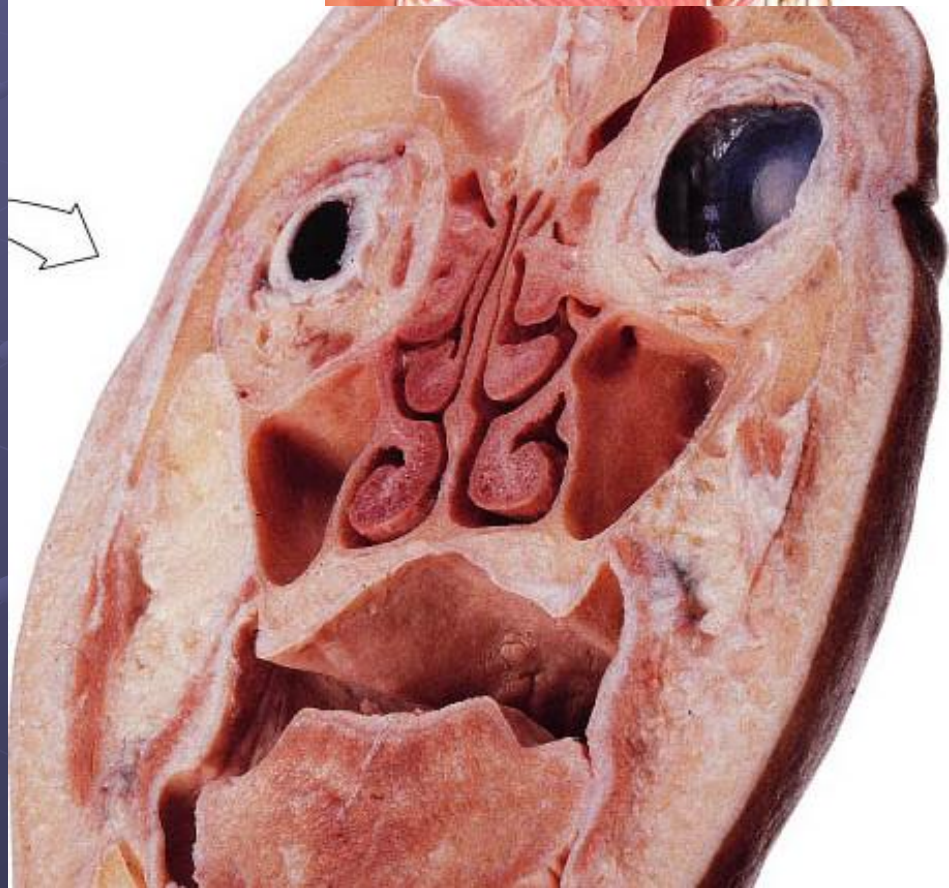
- external and internal nares = Nostrils
- Nose Hairs = vibrissae
- Alar cartilages on the nose
- Paranasal Sinuses
  - Fig 7.11 p 165



Upper Respiratory System

- 2. Nasal Cavity
- **Nasal Conchae:**
  - **Superior, middle and inferior**
  - **Other name: "Turbinate bones" because they create _____**
  - **Advantage ?**
- nasal septum
- hard palate, soft palate





Upper Respiratory System

3. Paranasal Sinuses

- Named after their bones
  - Frontal
  - Ethmoid
  - Sphenoid
  - Maxillary

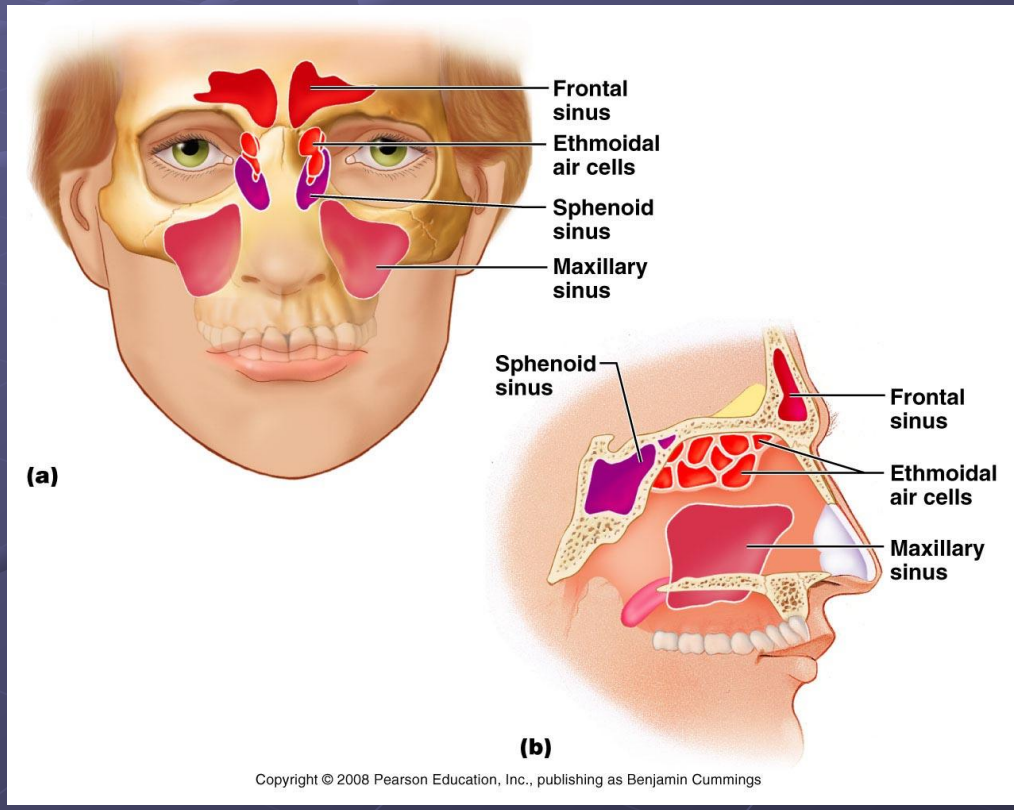


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Fig. 7.11, p 165

Upper Respiratory System

4) Pharynx

Shared passageway for respiratory and digestive systems

- nasopharynx - part above uvula and posterior to internal nares
- oropharynx – portion visible in mirror when mouth is wide open
  - fauces = the opening
  - uvula - posterior edge of soft palate
- laryngopharynx – between the hyoid bone & the esophagus

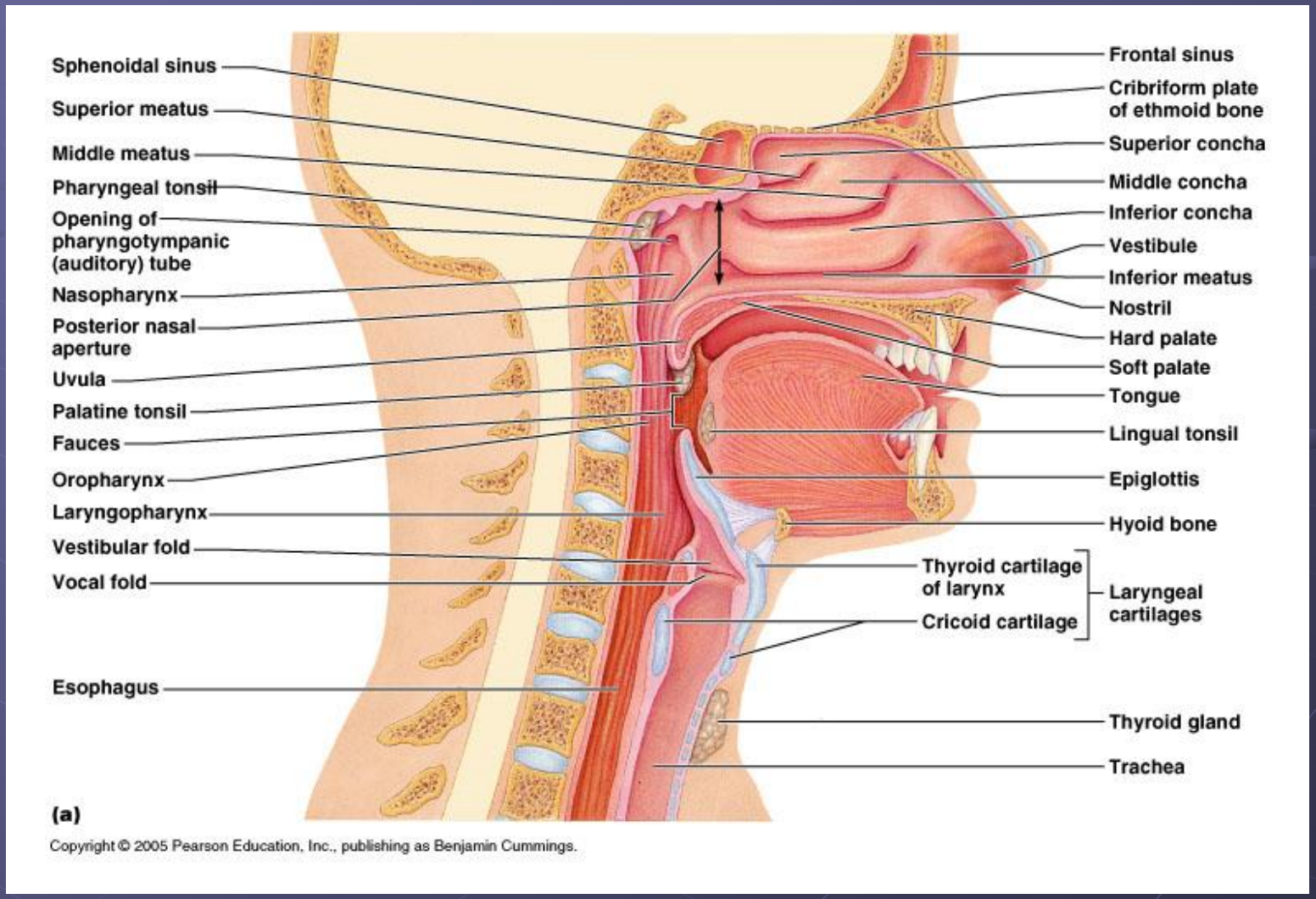

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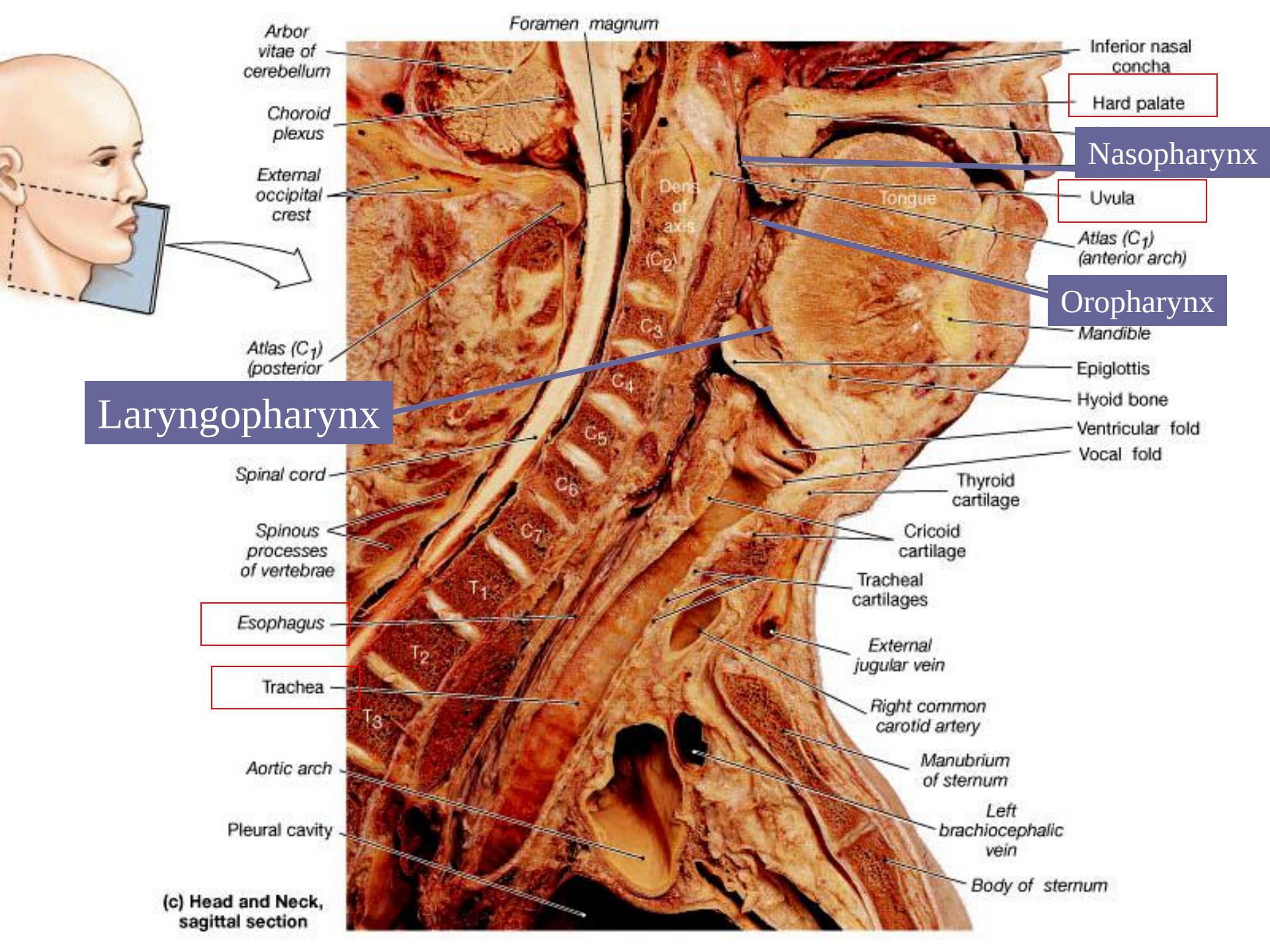
Fig. 22.3


Arbor vitae of cerebellum
Foramen magnum
Inferior nasal concha
Hard palate
Choroid plexus
Nasopharynx
External occipital crest
Dens of axis (C2)
Tongue
Uvula
Atlas (C1) (anterior arch)
Oropharynx
Atlas (C1) (posterior
C3
Mandible
Epiglottis
C4
Laryngopharynx
Hyoid bone
C5
Ventricular fold
Vocal fold
Spinal cord
C6
Thyroid cartilage
C7
Spinous processes of vertebrae
Cricoid cartilage
T1
Tracheal cartilages
Esophagus
T2
External jugular vein
Trachea
T3
Right common carotid artery
Aortic arch
Manubrium of sternum
Left brachiocephalic vein
Pleural cavity
Body of sternum
(c) Head and Neck, sagittal section

Lower Respiratory System = Anything inferior to the Pharynx

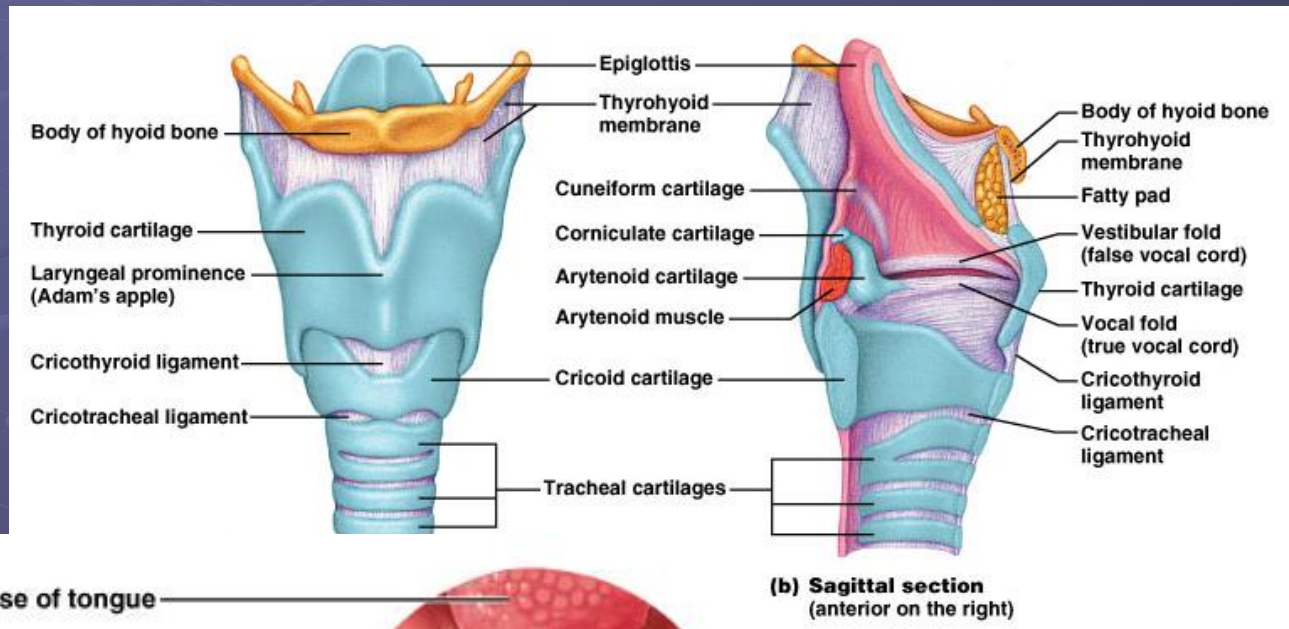
Larynx: Cartilaginous
C_4- C_7)

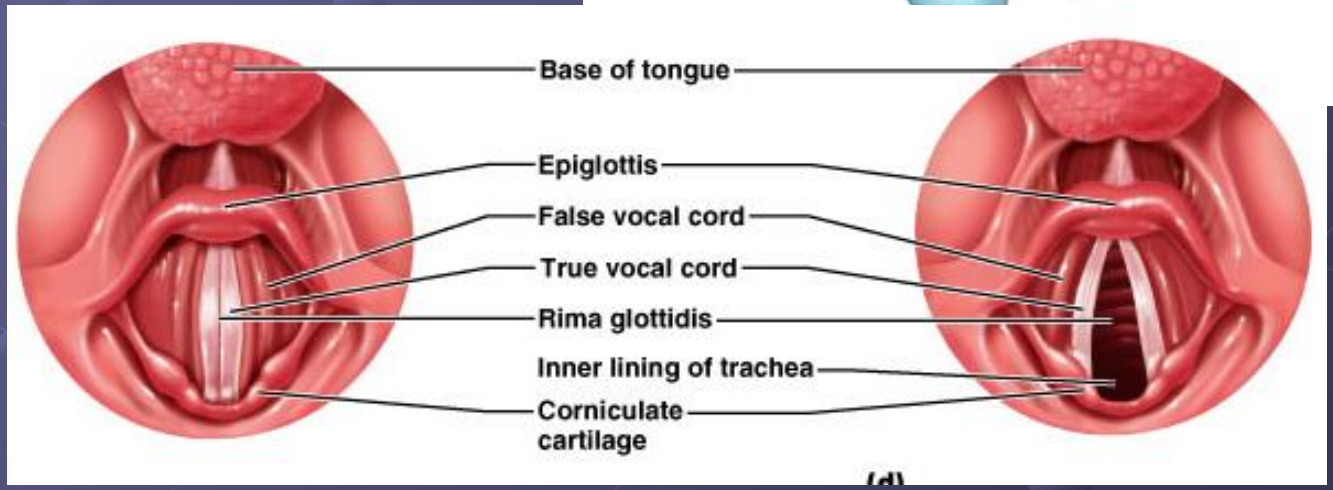
Made up of 9 cartilages

- 3 large unpaired (know these!) Thyroid, Cricoid, and Epiglottis
- 3 small paired (involved in construction of voice box)

Larynx (AKA voice box)

- Hyoid Bone
- Epiglottis
- Thyroid Cartilage
  - Adam's Apple
- Cricoid Cartilage
- Vocal Folds



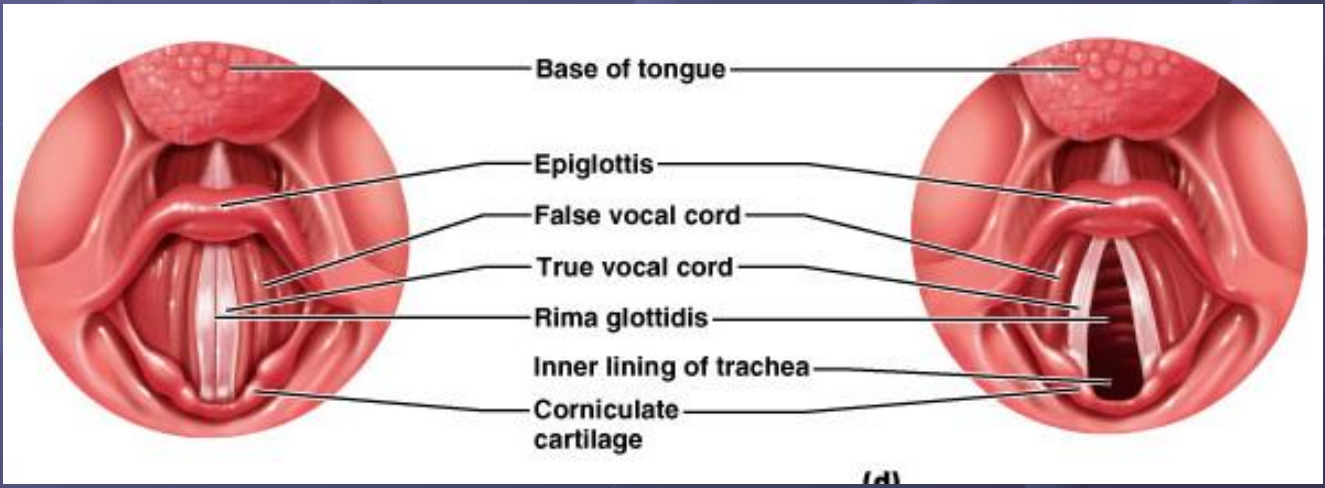


[Vocal cord stroboscopy]

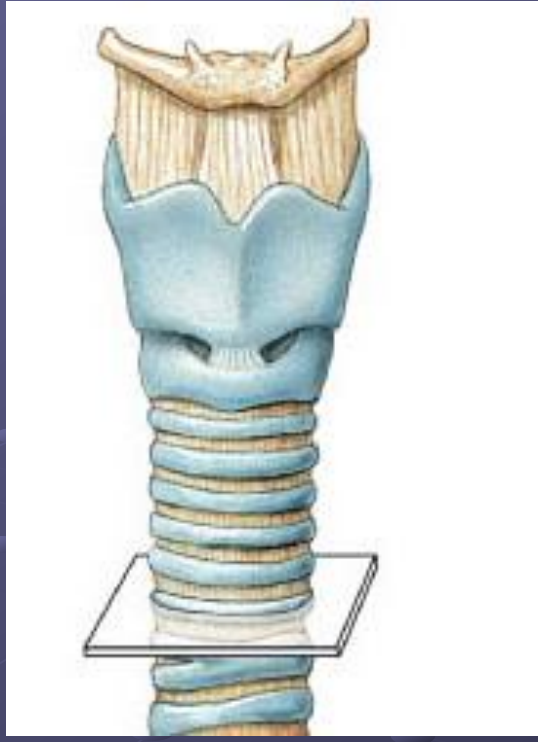
Larynx, cont'd

- The pitch of sound is from tension of the elastic fibers of the vocal folds
  - Resonance from shape of pharynx and mouth
- The glottis is the opening between the vocal folds
- Innervation via laryngeal nerves
  - Branches of CN X
  - Left recurrent laryngeal nerve loops around aorta

Vocal Folds video



Trachea (AKA windpipe)

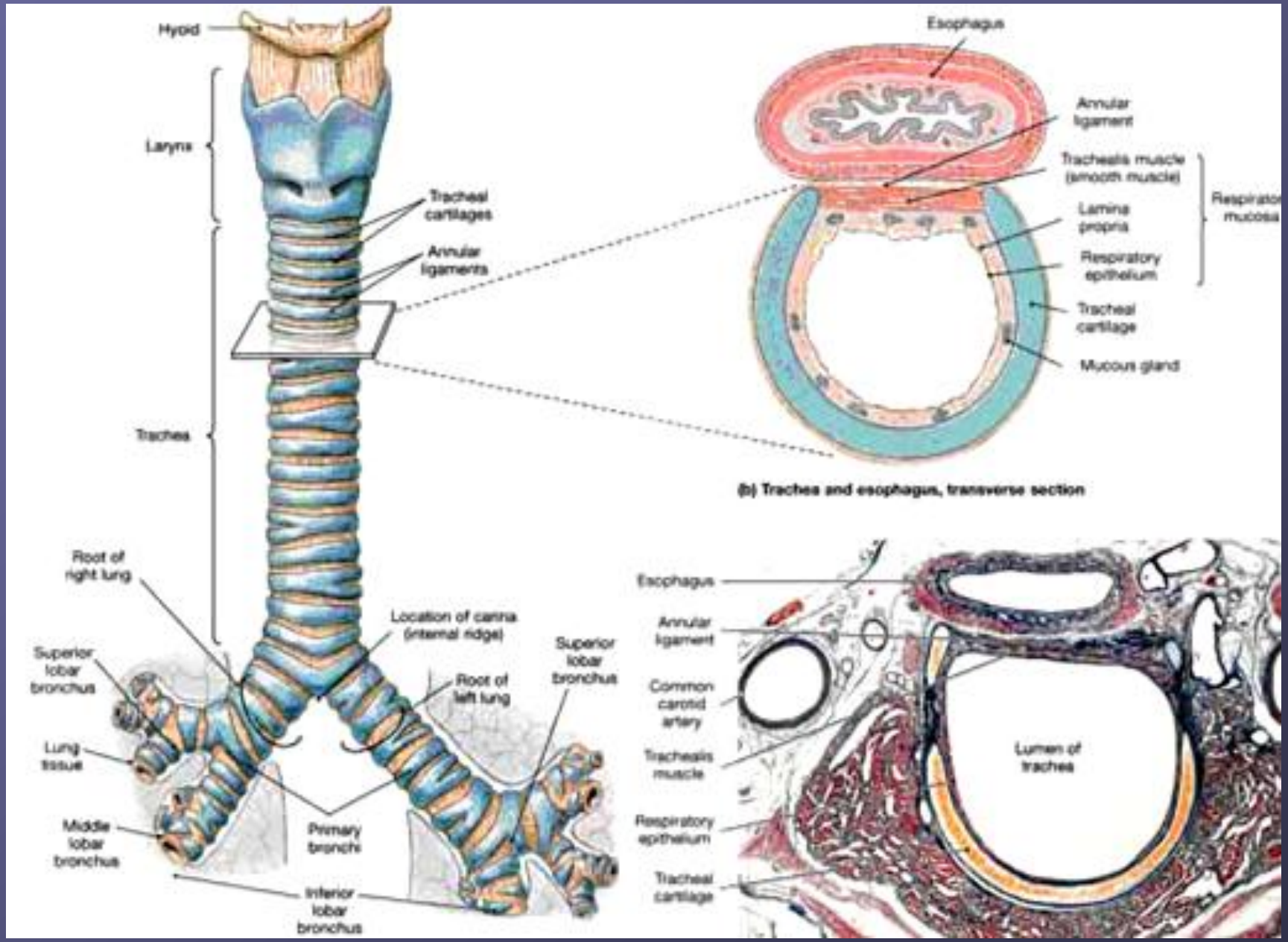


Passageway to lungs

Epithelial Lining ?

16 -20 incomplete hyaline cartilage rings (C-shaped) - completed by trachealis muscle.

Carina is the site of branching to left and right primary bronchi (AKA tracheal bifurcation)

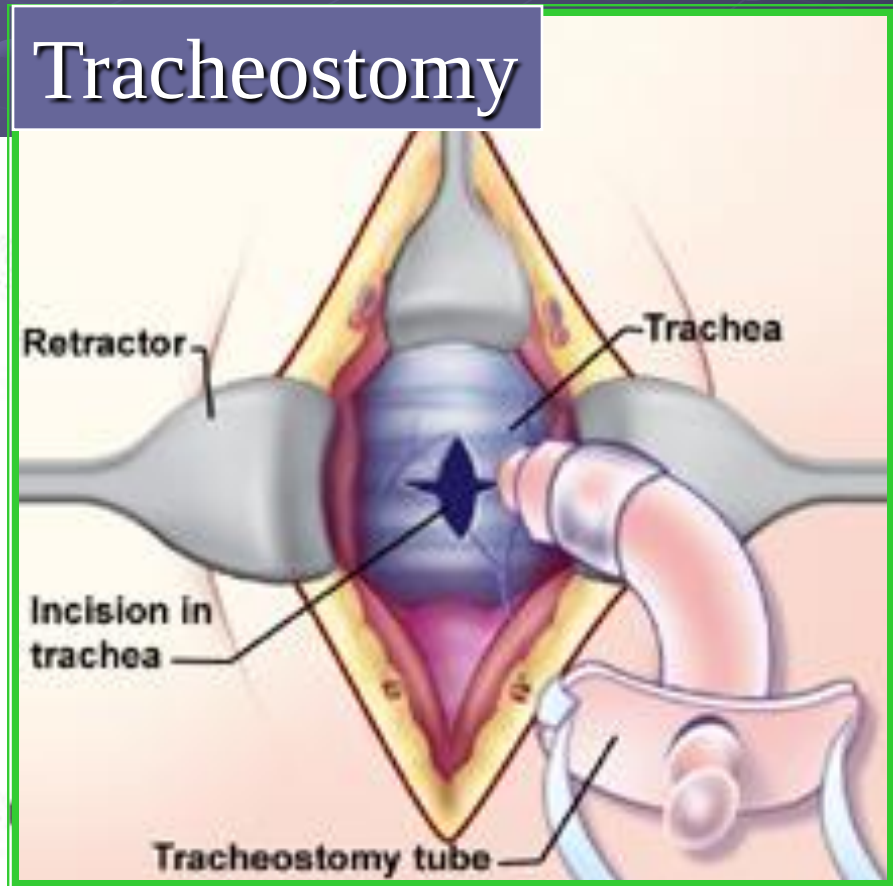

Hyoid
Larynx
Tracheal cartilages
Annular ligaments
Trachea
Root of right lung
Location of carina (internal ridge)
Root of left lung
Superior lobar bronchus
Superior lobar bronchus
Lung tissue
Middle lobar bronchus
Primary bronchi
Inferior lobar bronchus
Esophagus
Annular ligament
Trachealis muscle (smooth muscle)
Lamina propria
Respiratory epithelium
Tracheal cartilage
Mucous gland
Respirator mucosa
(b) Trachea and esophagus, transverse section
Esophagus
Annular ligament
Common carotid artery
Trachealis muscle
Respiratory epithelium
Tracheal cartilage
Lumen of trachea

Tracheal Blockage

Heimlich Maneuver or abdominal thrust

or

Tracheostomy



From Bronchi to Lungs: The Bronchial Tree p 645

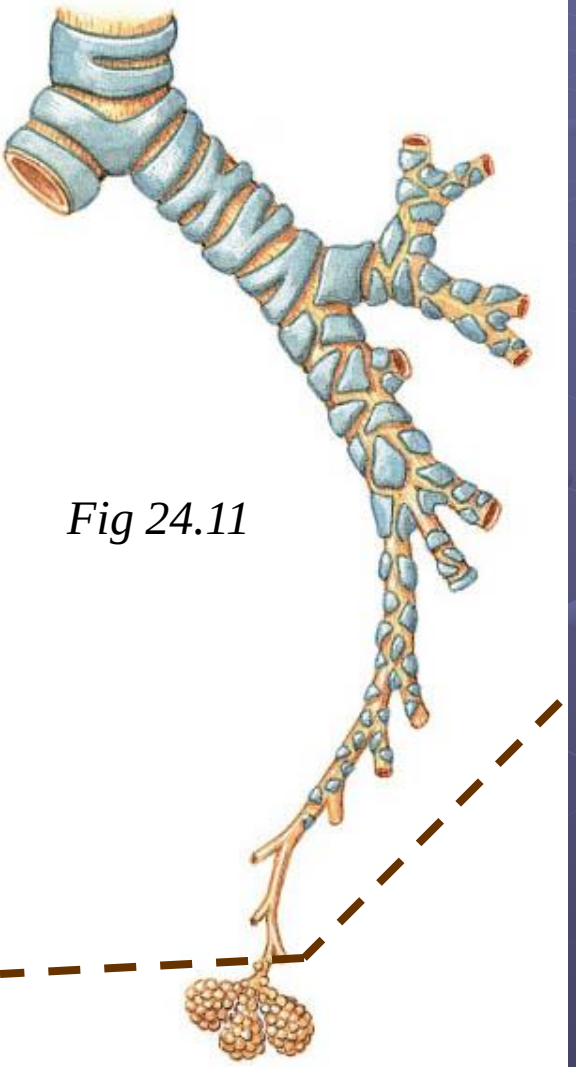


Fig 24.11

- **1˚ (main) bronchi (**enter lungs at hilus, complete cartilage rings)
- **2˚ bronchi** (from now on cartilage plates)
- **3˚ bronchi**
- **Bronchioles**
- **Terminal bronchioles**
- **Respiratory bronchioles**

Conducting portion

- **Alveolar ducts**
- **Alveolar sacs**

Respiratory portion

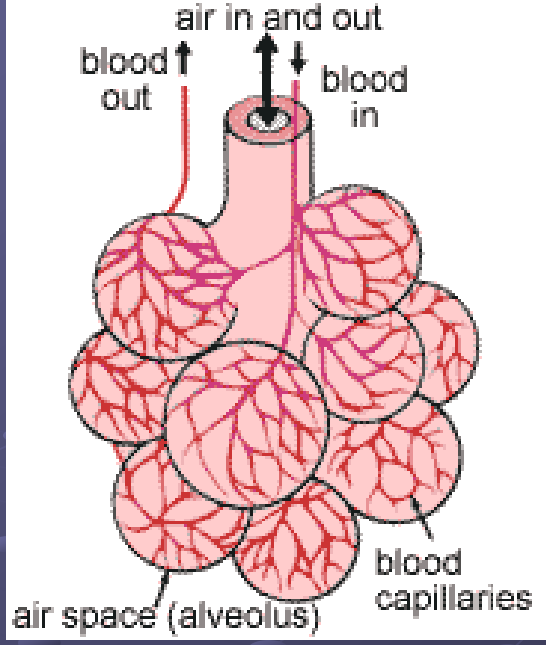
Note: Sympathetic stimulation (epinephrine) causes bronchodilation

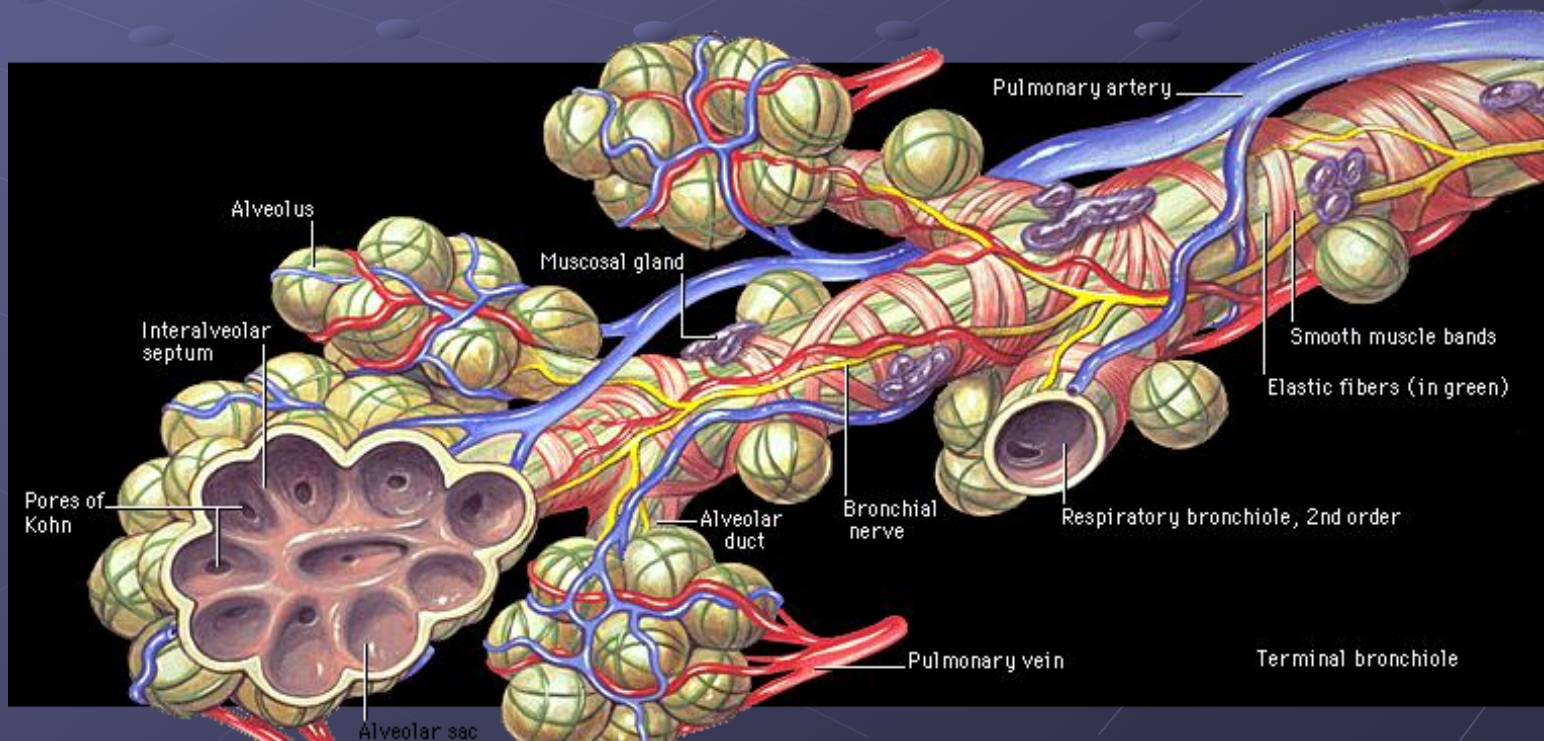
The Respiratory Zone p 646

Alveoli are site of gas exchange

Close association with capillaries

Lots of elastic fibers in alveolar wall

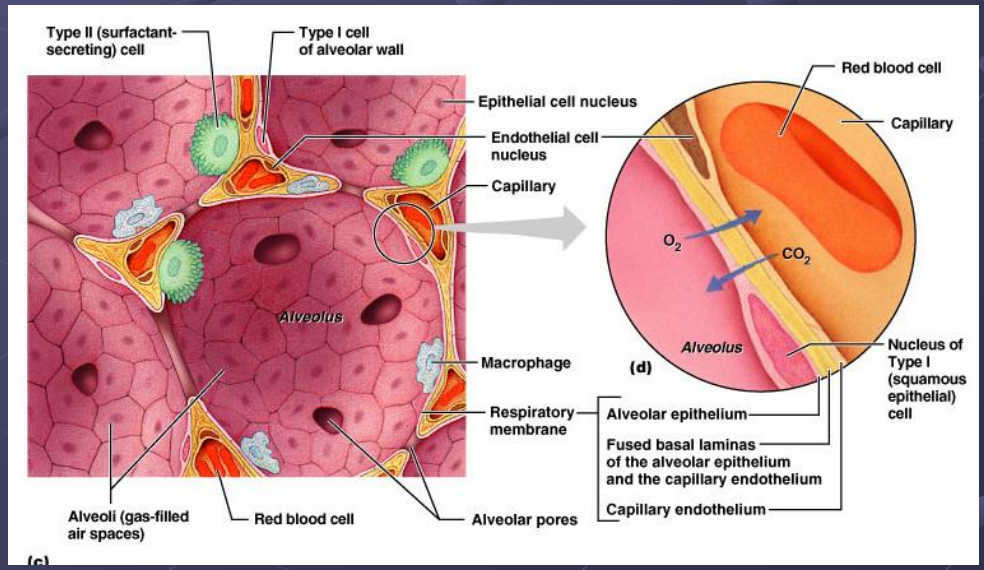


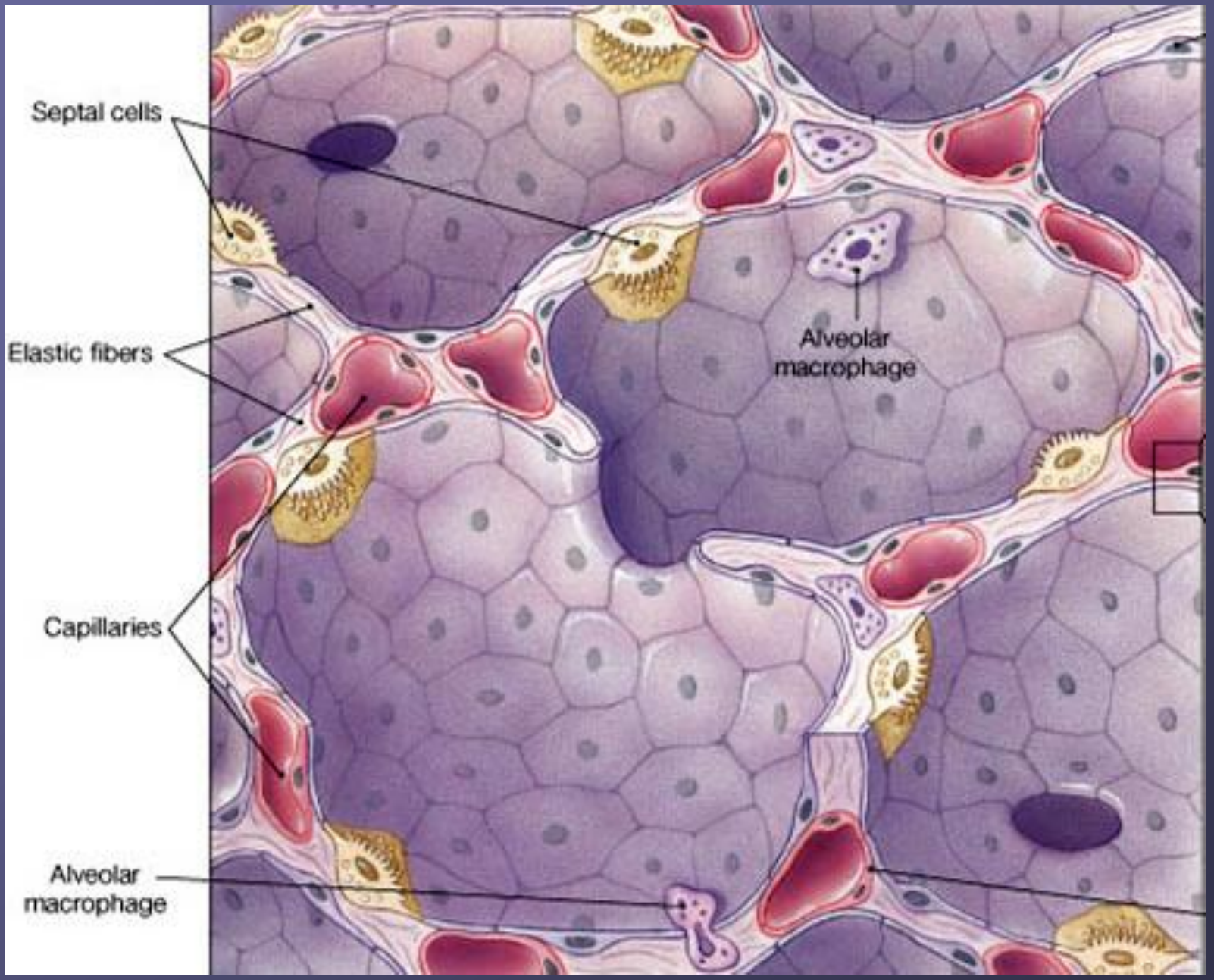


Alveoli (singular: alveolus)

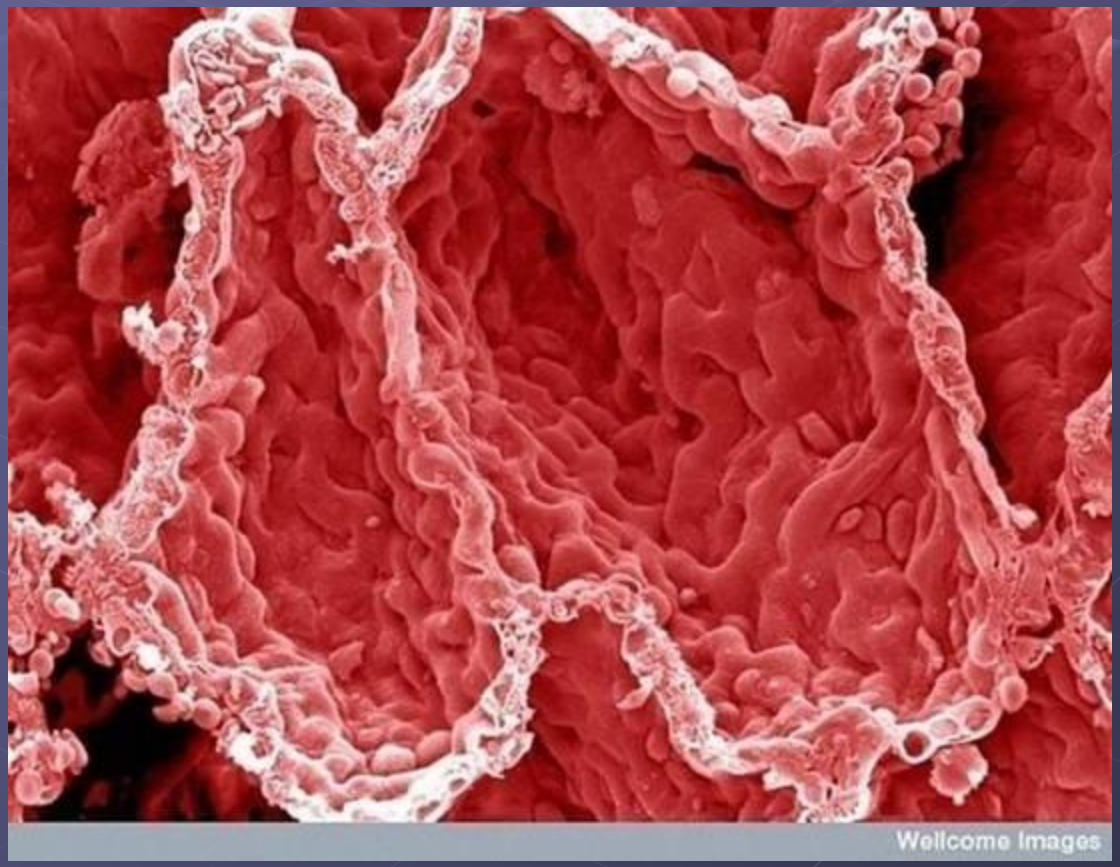
Alveolar cells

1. Type I cells – respiratory epitheliocytes
2. Type II cells – septal cells – produce surfactant, which prevents collapse of alveoli
3. Alveolar Macrophages – dust cells – phagocytic




Septal cells
Elastic fibers
Capillaries
Alveolar macrophage
Alveolar macrophage

SEM of alveoli

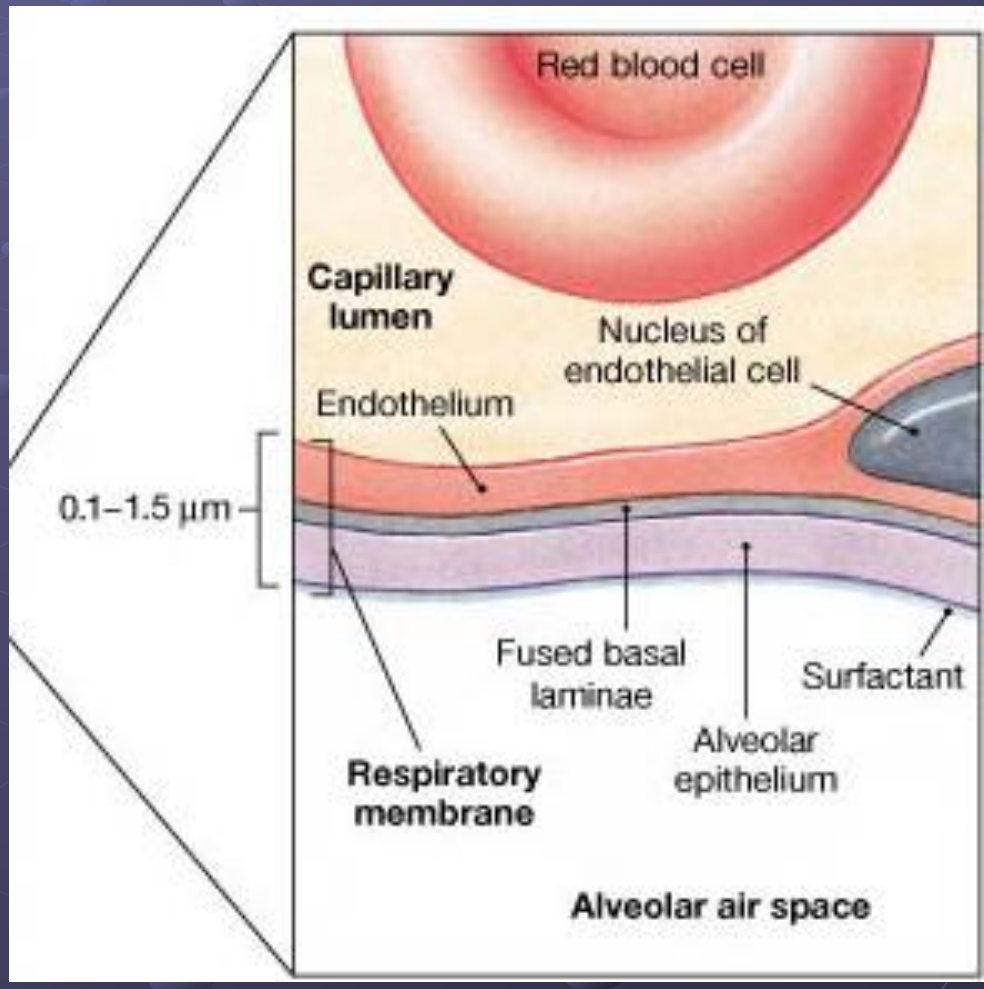


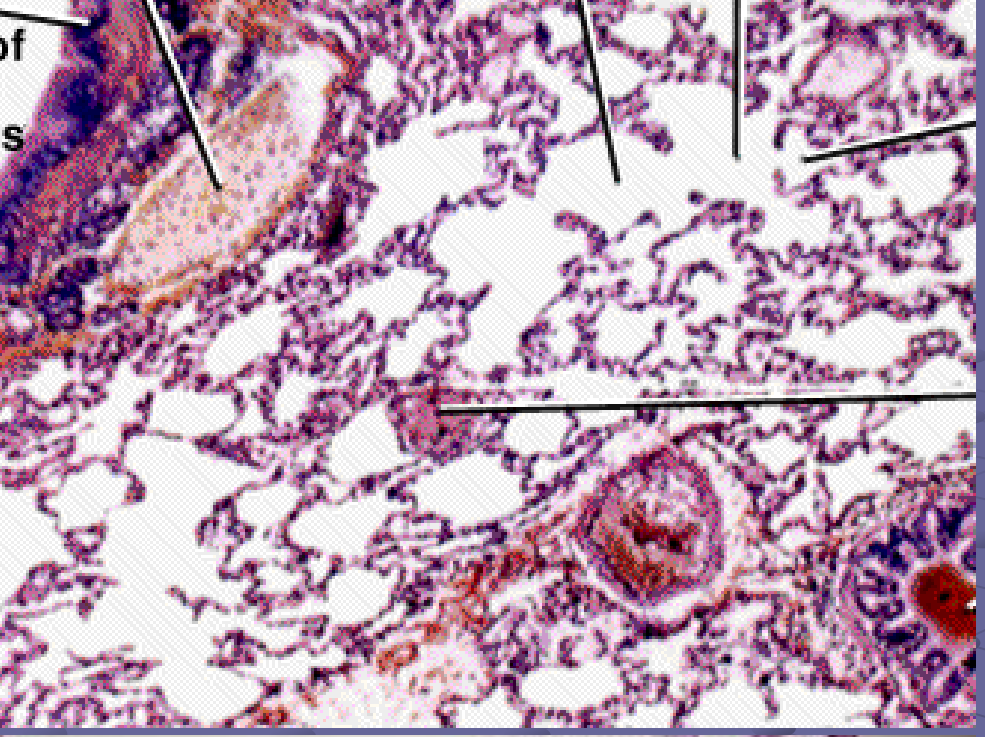
Respiratory Membrane

Different from respiratory epithelium

Super thin. Made up of 4 layers:

1. **endothelium of capillary**
2. **basement membrane of capillary endothelium**
3. **basement membrane of epithelium of alveolus**
4. **epithelium of alveolus**





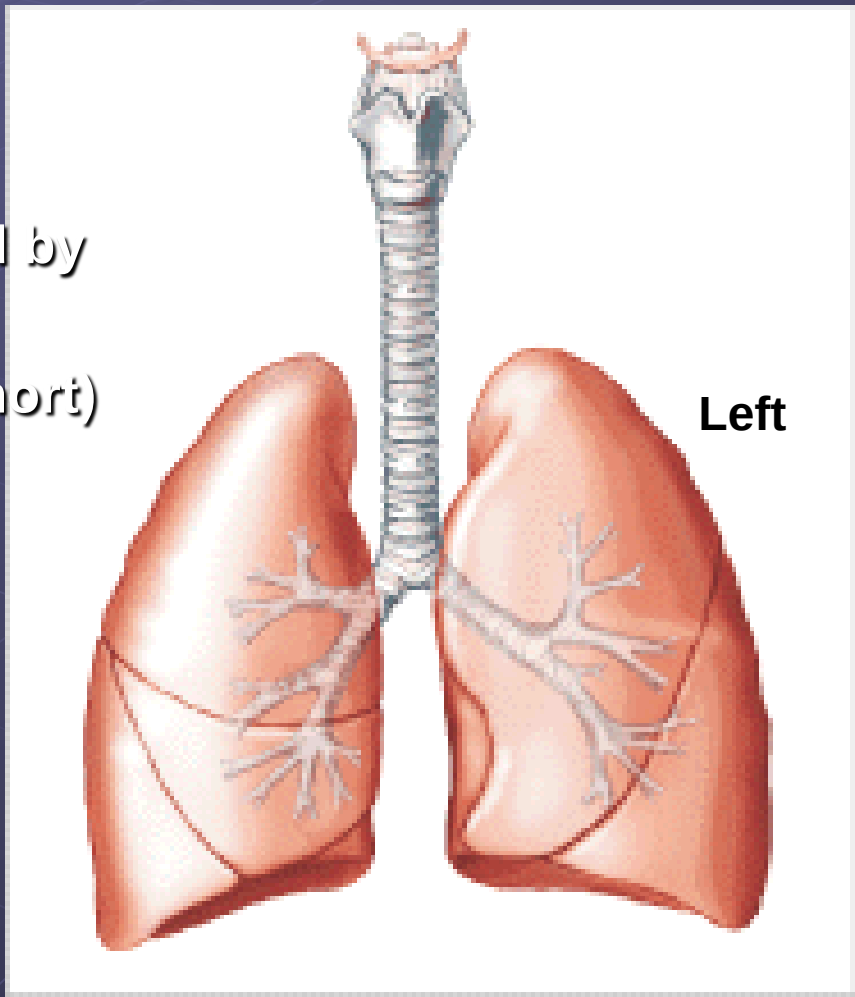
Emphysema

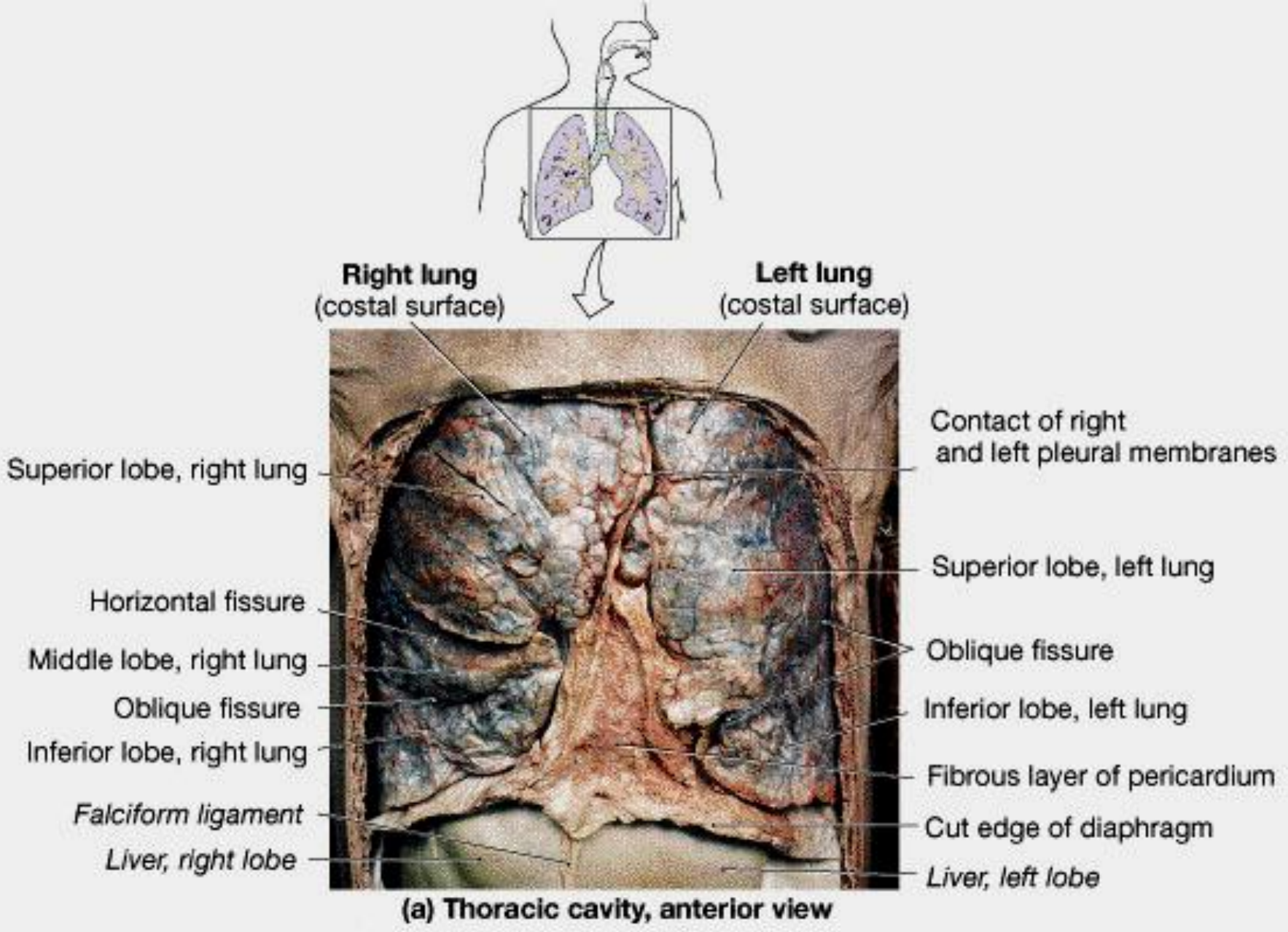
Chronic progressive enlargement of alveoli accompanied by destruction of their wall and decrease in surface area for exchange

Due to prolonged exposure to respiratory irritants (??)

Lungs

- Situated in Pleural (thoracic, chest) Cavity
- Subdivided into lobes (each supplied by 2° bronchus)
- Right lung: 3 lobes (rel. broad and short)
- Left lung: 2 lobes (long and narrow)
- Right and left lung separated by the mediastinum
- Lung hilus

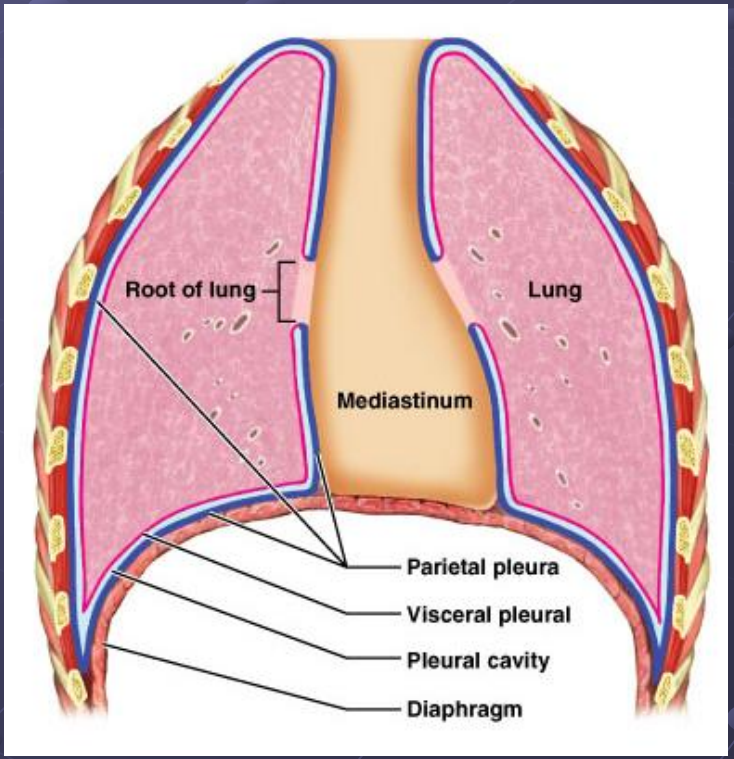




(a) Thoracic cavity, anterior view

Pleural Cavities and Membranes

- **Two cavities separated by mediastinum**
- **Lining of cavities**
  - **Parietal Pleura**
  - **Visceral Pleura**
  - **Pleural Cavity**
- **pleurisy**
- **Pneumothorax, (hemothorax, pyothorax, pleural effusion)**



Pleural Cavities and Membranes, cont'd

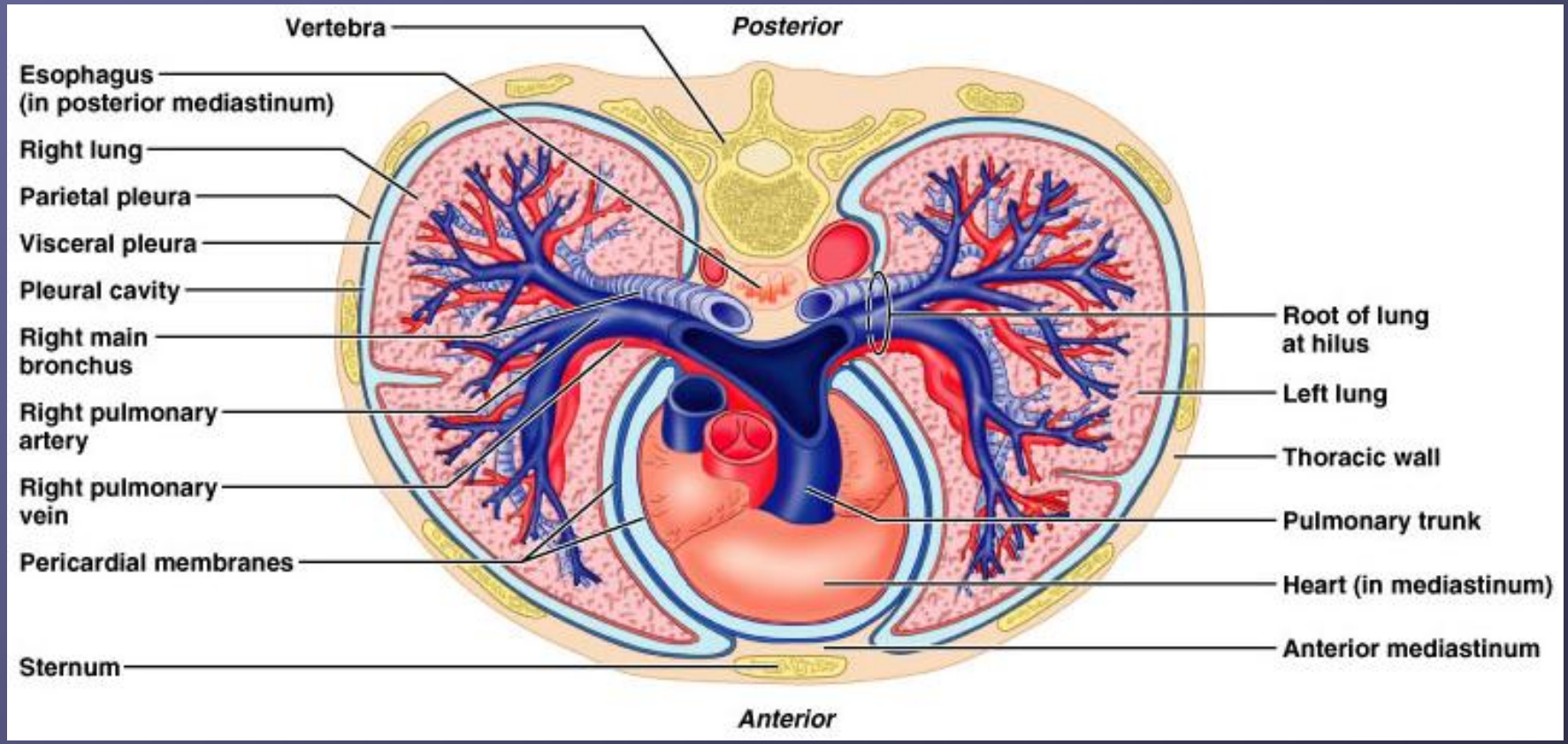
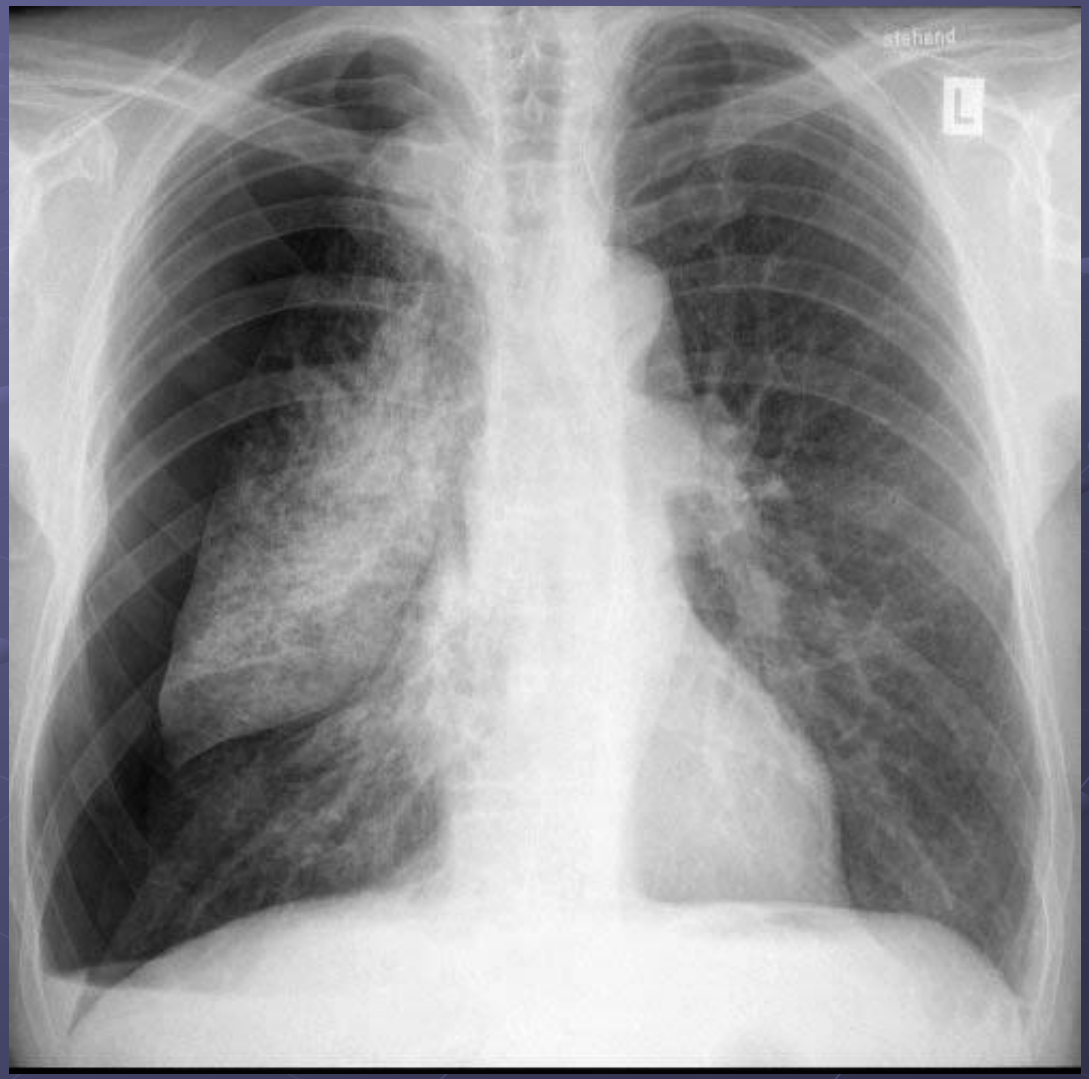


Fig 21.13

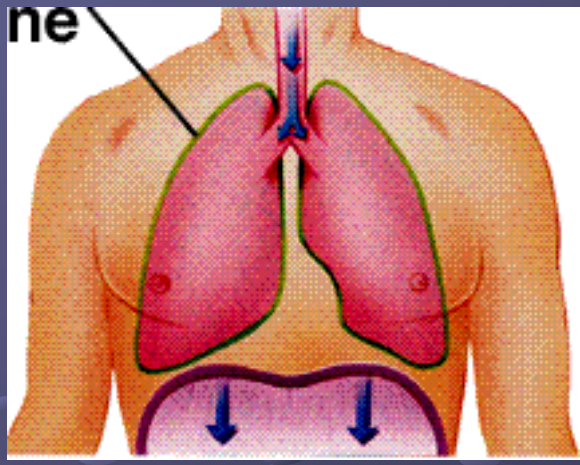
Pneumothorax



Ventilation

- Inspiration = Inhalation
- Expiration = Exhalation
- Respiratory Muscles
- Neural Control:
  - Medulla
  - Chemoreceptors (fig. 22.17)
    - Carotid bodies
    - Aortic bodies

Respiratory Muscles

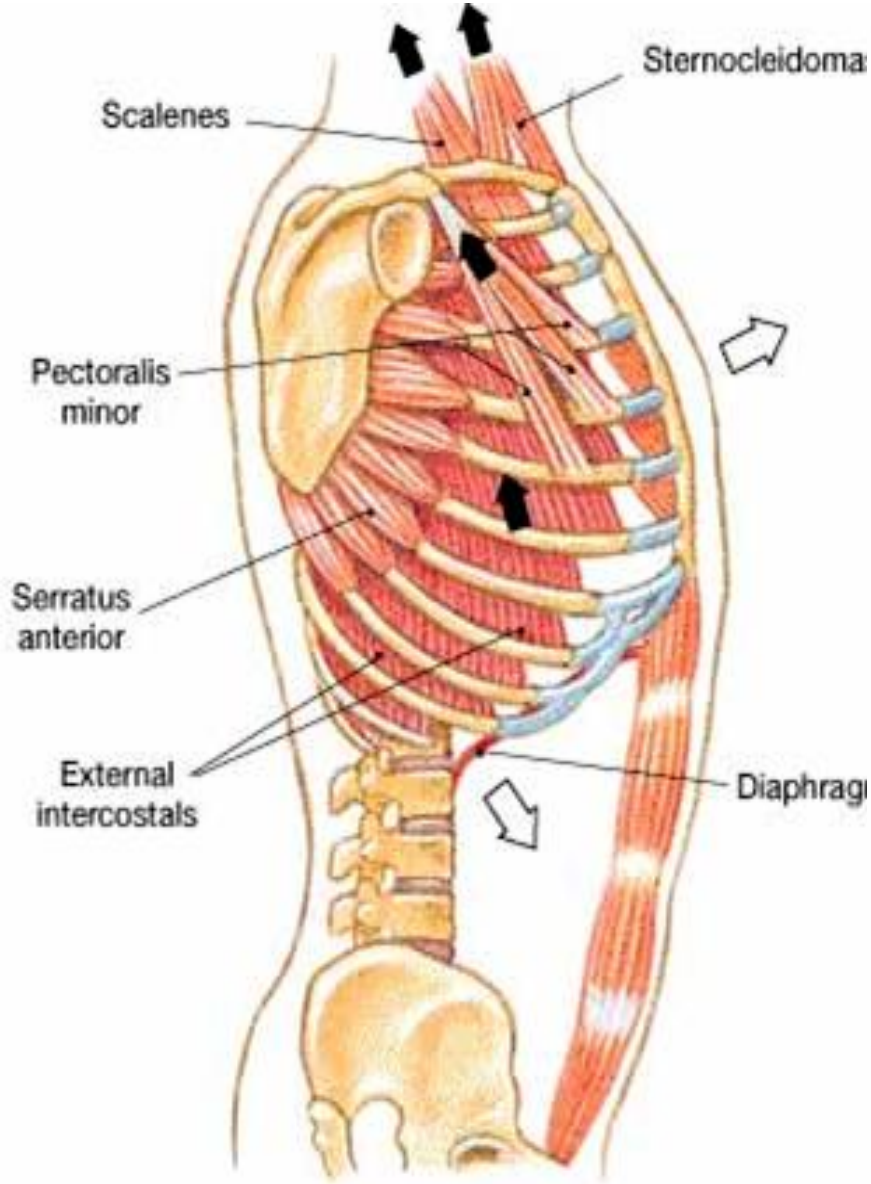


Diaphragm: depresses on contraction ⇒ inhalation

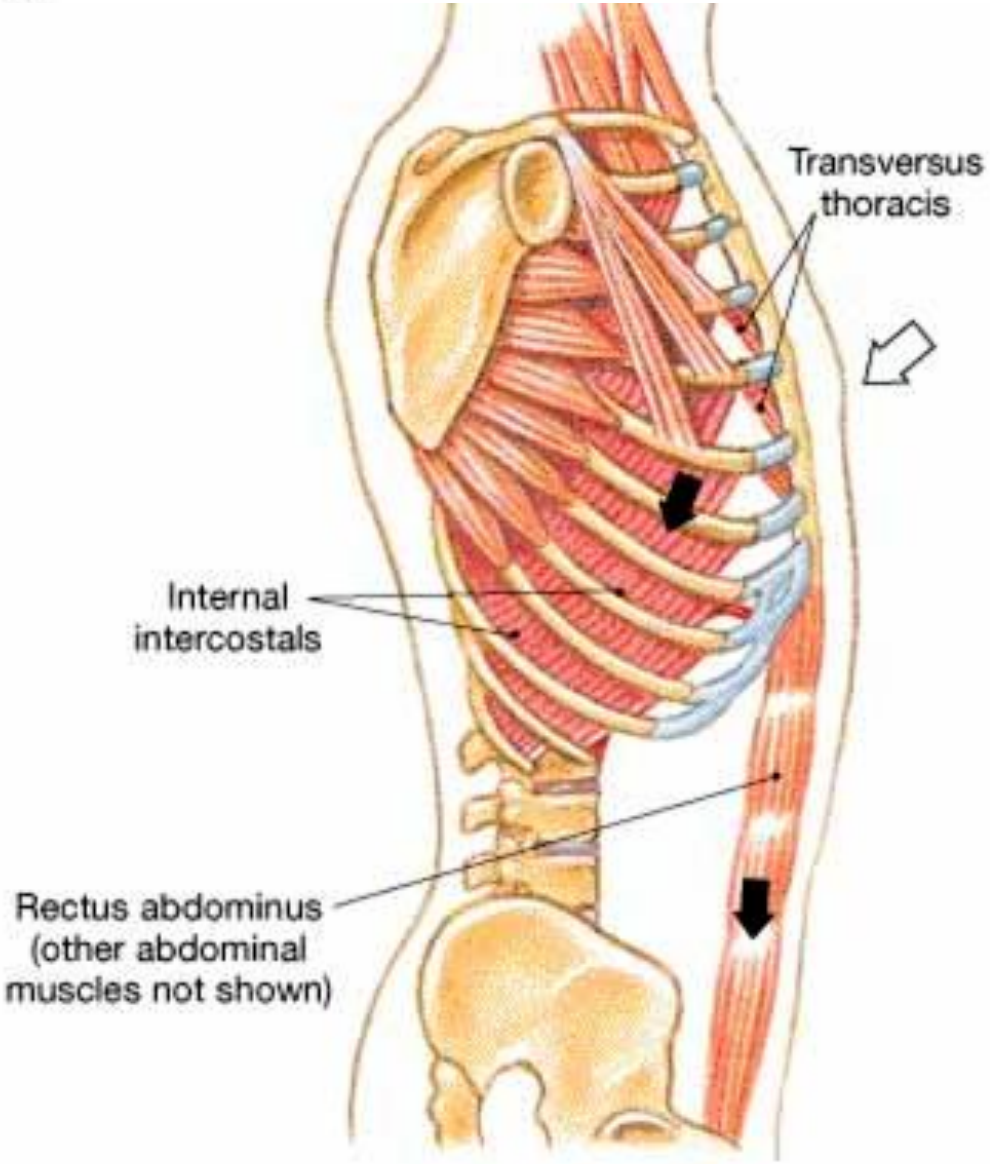
External intercostals: elevate ribs ⇒ inhalation

Internal intercostals: depress ribs ⇒ active exhalation

(Accessory muscles - serratus anterior, scalenes, pectoralis minor, sternocleidomastoid, internal and external obliques, transverse abdominus, rectus abdominus)

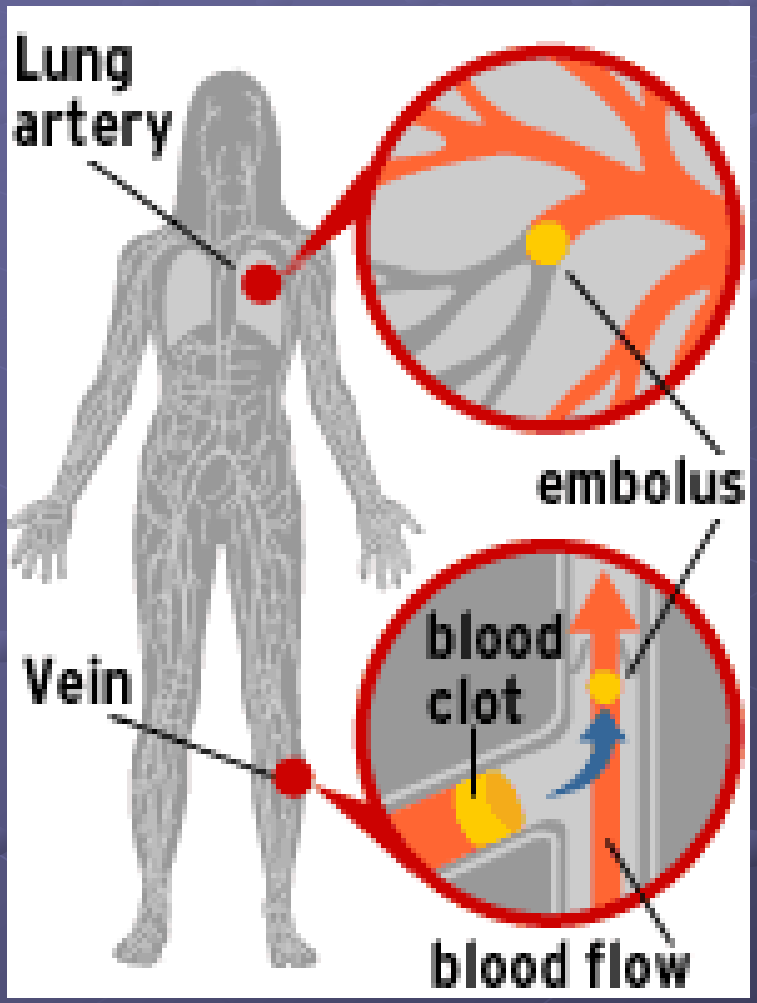


(c) Inhalation



(d) Exhalation

Pulmonary Embolism



Causes for development of emboli in veins of legs:

- Immobilization
- Trauma
- Long surgeries
- Oral contraceptives
- Obesity
- Cigarette smoking
- Hypertension